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**SecondSemester 2023-2024**

# Course Handout Part II

Date: 09.01.2024

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.: CS F437

Course Title: Generative Artificial Intelligence

Instructor-in-Charge: Prof.N.L.Bhanu Murthy

### 1. Scope and Objectives

This course is an introductory course on Generative Artificial Intelligence. The course commences withoverview on Generative vs Discriminative models and Bayesian network vs neural networks. The main emphasis of the course is on popular generative modes like Autoregressive models; Variational autoencoders; Normalizing flow models; Generative adversarial networks; Energy-based models. The course also focusses on learning data distribution and discrete Latent Variable models. The necessary evaluation metrics for generative will also be discussed. The course also exposes students to some applications of generative models to NLP, Computer Vision etc.

This course aims to achieve the following goals:

* To introduce students to the algorithmic aspects of generative models and enable them to understand the basic underlying mathematical concepts and methods.
* To introduce students to research and development work in generative models and conditional generative models for vision, NLP, Image translation, machine translation, etc.
* To enable students to build generative AI applications with the necessary implementation skills.

2. Pre requisites:

BITS F464: Machine Learning or CS F429: Natural Language Processing

##### 3. Text Books

T1. Probabilistic Machine Learning, Advanced Topics - Kevin P. Murphy, The MIT Press, 2023

**Reference Books:**

R1: Deep Generative Modeling, Jakub M.Tomczak, Springer, 2021

R2: Deep Learning by Ian Goodfellow, YoshuaBengio and Aaron Courville

R3: T1: Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer – 2013

**4. Course Plan**

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| Lecture No | Learning Objectives | Topics to be covered | Chapter in the Text Book |
| 1 | To introduce the course | Introduction to Generative Artificial Intelligence | T1: 20.1, 20.2 andClass Notes |
| 2 - 4 | To understand the significance and goals of generative modeling | Generative vs Discriminative; Bayesian Network vs. Neural Network; Goals of generative modelling | T1: 20.3, Class Notes |
| 5 – 10 | To understand Variational autoencoders | Introduction to variational autoencoders (VAE), the model and objective, ELBO, components of VAE, reparameterization trick | T1: 21.1, 21,2, 21,3, Class Notes |
| 11 – 16 | To understand autoregressive models | Autoregressive Models, Neural Autoregressive Density estimation (NADE) | T1: 22, Class Notes |
| 17 -18 | To learn metrics to evaluate generative models | Evaluating generative models | T1: 20.4, Class Notes |
| 19 - 24 | To understand Generative Adversarial Networks | Likelihood-free learning, Discriminator, GAN, J-S Divergence, beyond JS and KL divergence | T1:26, Class Notes |
| 25 – 29 | To learn normalizing flow models | Normalizing flow models, Change in variables,Jacobian Determinant, Designing invertible transformations | T1: 23, Class Notes |
| 30 - 34 | To understand energy-based models and focus on their application as generative models | Parameterizing probability distributions, energy-based model, restricted Boltzmann machine, Deep Boltzmann Machines | T1:24, Class Notes |
| 35 - 38 | To learn diffusion generative models | Denoising diffusion probabilistic models, Encoder (forwards diffusion), Decoder (reverse diffusion), Model fitting | T1:25, Class Notes |
| 39 - 40 | To have an exposure to topics like learning data distribution and discrete Latent Variable models | Learning data distribution and discrete Latent Variable models | Class Notes |

##### 5. Evaluation Scheme

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| **Component** | **Duration** | **Weightage** | Date&Time | **Nature of Component** |
| Mid Semester Test | 90 mins | **35%** | 11/03 - 4.00 - 5.30PM | Closed |
| Assignments | - | **25%** | TBA | Open |
| Comprehensive | 3 hours | **40%** | 07/05 AN | Closed |

Note: At least 40% of the evaluation components for Mid-semester grading.

**6. CHAMBER CONSULTATION HOUR:** Tuesday 5PM – 6PM

**7. Make-up:** Make-up will be granted only to genuine cases with prior permission only. No makeup for class participation and assignment.

**8. NOTICES:** All notices will be put up in CMS and students are strongly advised to log in to CMS and look for notices quite often.

**9. Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-charge**

**CS F437**